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THE USE OF EDUCATIONAL TECHNOLOGY IN PROVIDING KNOWLEDGE OF EDUCATIONAL TECHNOLOGY AND SUGGESTIONS FOR ITS APPLICATION TO SCIENCE SUPERVISORS. FINAL REPORT.

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REPORTED ARE THE PRELIMINARY ACTIVITIES FOR THE PREPARATION OF AN INSTITUTE FOR SCIENCE SUPERVISORS. THE PROJECT, PLANNED TO CULMINATE IN A TEN-DAY WORKSHOP-SEMINAR FOR SCIENCE SUPERVISORS, WAS DIVIDED INTO THREE DEVELOPMENTAL PHASES--(1) IDENTIFICATION OF THE NEEDS OF SCIENCE SUPERVISORS AND DEVELOPMENT OF BEHAVIORAL OBJECTIVES FOR THE WORKING CONFERENCE, (2) DEVELOPMENT OF PLANS FOR THE WORKING CONFERENCE, MATERIALS FOR THE CONFERENCE, AND POST-CONFERENCE MATERIALS, AND (3) THE SUPERVISOR'S CONFERENCE, AND DISTRIBUTION OF POST-CONFERENCE MATERIALS. PHASE I INVOLVED (1) CALLING OF A TWO-DAY MEETING OF SUPERVISORS TO ORDER STRUCTURE, (2) ESTABLISHING A SET OF EDUCATIONAL OBJECTIVES, AND (3) CONTACTING APPROPRIATE INDUSTRIAL REPRESENTATIVES. THIS REPORT COVERS PROGRESS THROUGH PHASE II OF THE PROJECT. APPENDIXES INCLUDE MATERIALS DEVELOPED FOR THE PROJECT, A STATEMENT OF OBJECTIVES, AND A BIBLIOGRAPHY. (DH)

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January, 1968

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HEALTH, EDUCATION, AND WELFARE

Office of Education
Bureau of Research

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Dr. Albert Eiss

National Science Teachers Association

Washington, D.C.

January, 1968

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U.S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE

Office of Education
Bureau of Research

REPORT ON STAGE I:

PRELIMINARY PLANNING, INCLUDING THE DEVELOPMENT OF BEHAVIORAL OBJECTIVES

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ACKNOWLEDGEMENTS:

At this point it is necessary to acknowledge the contributions of certain people who contributed both to the successful operation of the project and to the preparation of this report. The highest credit must go to Dr. Gabriel D. Ofiesh, Director of the Center for Educational Technology at The Catholic University of America. As Chief Consultant he participated actively in every phase of the project and contributed more than his share of advice and help. In addition, other consultants such as Miss Ellen Ouhl and Mr. George H. Ziener, both with the Center for Educational Technology were insturmental in the successful operation of the planning sessions and in the report preparation. Their interest and involvement were of considerable assistance.

SUMMARY:

The following report covers the first phase in the preparation of an institute for science supervisors. In order to prepare such an institute certain initial steps were taken:

I. A two-day meeting of supervisors was held in order to structure,

II. A set of educational objectives for such an institute.

III. Initial contacts were made with industry in order to determine interest in the institute and information on presently available software for use in the institute.

The purpose of such initial planning was an attempt to apply the principles of Educational Technology in the structuring of the institute. Materials ultimately produced in the next phase of preparation will be designed for self instructional use and specifically designed to meet the learning patterns of the participants and fill objectives developed in this project. These objectives are listed in appendix d of this report.

The availability of of-the=shelf software material as well as industrial interest in developing such material are important factors in the planning of the instutute. Indications of interest and general comments were sought from firms that might be involved in this area of activity. The letters circulated and summaries of the responses are indicated in appendix a and b of the report.

From the above information it was possible to develop a work schedule for a six month development program and for package development design to meet the needs of the proposed institute. The resulting time table was expanded from six months to twelve months of activity in light of the objectives obtained and the time necessary for preparation of material in self-instructional form. (Appendix e,f,g)

INTRODUCTION

A few years ago, only the largest school systems had an employee who as assigned the task of promoting the development of curriculum and encouraging effective teaching of science. Only recently have school systems coordinated these efforts on at least a K-12 basis. Today, there is a rapidly increasing number of science supervisors who are assigned this responsibility. The present Registry of science supervisors, maintained by the National Science Teachers Association, lists nearly 7000 individuals who are assigned to this task on either a part-time or a full-time basis. Many of these individuals ask the National Science Teachers Association for assistance in planning supervisory programs. There is a need for developing a working program to meet this need--a program that will take into consideration present developments in the field of science education.

The nation's schools are in an era of rapid change. It is essential that this change will result in better rather than in poorer quality education. One of the changes that is taking place in the administrative organization of the science program in the schools is the trend toward larger school systems, with science programs on a K-6, 7-12 or K-12 basis, directed by a science coordinator or supervisor. More often than not, these supervisors are selected from the better science teachers in the district. Often, they have had little or no training in supervision;

indeed, there are few schools and universities in the country where such training is available, and some of that which is offered is far from adequate.

Bentley Glass wrote in Supervision for Quality Education in Science,[1] "There are so few science teachers among all teachers, and among the science teachers themselves there are so few who have had ehough of the right kind of work to get a real understanding of the nature of science. And yet, if we are going to develop a civilization that is broadly and soundly based upon a scientific foundation--and we can hardly escape that now--then the general citizen of this country, the man in the street, must learn what science truly is, and not just what science can bring about." But, those who are in positions of potential leadership for improvement in science education must be equally well versed in the elements of change in education and the direction of change of the context in which science education must.take place. Nevertheless, the necessity of developing courses of study to achieve this goal, and of guiding poorly prepared teachers to use the materials in understanding this task, is one inescapable responsibility of the science supervisor.

Another change in education gives promise of becoming of great significance to science supervisors. This is a trend toward greater use of a wide variety of teacher techniques involving educational technology. The formation of several major industrial complexes that plan

[1]U.S. Office of Education, Supervision for Quality Education in Science. U.S. Government Printing Office, Washington, D.C., 1963.

to invest large amounts of time and money in the development of both hardware and software for educational purposes will inevitably result in a major impact upon educational practices in our schools. The science supervisor must not remain uninformed of these devices and uninvolved in the production of educational materials. He must become acquainted with new teaching techniques, some of which represent major changes in educational philosophy. He must be prepared to select wisely from among many alternatives and prepare inexperienced teachers to use the materials effectively in the classroom. The National Science Teachers Association wishes to assist the science supervisors in facing these problems and in identifying possible solutions.

Also, there is a need to bridge the gap between industry and education, so that the cooperative efforts of both may result in better educational materials than either could produce separately. Unless this is done, the educator may find, for the second time in little more than a decade, that decisions concerning content and methodology will be made without his leadership role in the planning process. There is a need to begin this cooperative process as soon as possible because, in a field as new as that involving programed instruction and the system approach to teaching science, as well as with other equally significant innovations, much preliminary experimentation and research will be necessary in order to develop a truly effective and fully adequate program of science education. A science program will not spring, full blown, from a carefully programed computer, but must be designed through the

careful analysis and thorough study. Above all, it must reflect the most acceptable approaches in science content and teaching methods, rather than merely following the easy path of adapting, admittedly, ineffective existing programs for computerized instruction.

An excellent subject for initial experimentation with new educational technology is the development of materials to assist science supervisors in learning how to work more effectively. In the first place, most science supervisors are already well prepared in science and pedagogy. They would be more able to evaluate and make suggestions for improving programed materials. In the second place, if supervisors use new equipment and new techniques in the learning process, it will be the most effective way of alerting them to the potential values of such an approach. A third reason for developing programs of instruction for supervisors is that there are few existing materials available. If new materials must be developed, why not use more modern teaching techniqes, and avoid producing instructional materials that would be outdated by the time they were completed? Still another reason for utilizing these new instructional techniques is that they are particularly well adapted for individualized instruction. Science supervisors are somewhat isolated in their school systems from others with similar responsibilities. Therefore, programs that can be pursued on an individual basis would be especially useful to this group.

The National Science Teachers Association wishes to take an active part in this developmental process. The Association is making tentative

plans to hold a ten-day workshop-seminar for science supervisors in March, 1969. NSTA would like to use the most modern teaching techniques presently available for the project and, at the same time, acquaint science supervisors with new technological innovations that will become increasingly common in tomorrow's schools. The Association believes that the supervisors should have the opportunity to see, to feel, to use, and to explore firsthand, in the operation of such equipment and in the development of educational materials for use with these media.

Present plans, although tentative, envisage the enrollment of 75-80 science supervisors who will have the support of their districts in developing new programs and supporting change in science teaching in their local school systems. Perhaps fifteen or more industrial producers of educational hardware will be asked to assist in the project by providing the hardware, consultants, and by assisting in developing the necessary programed materials on a self-sustaining basis. No support funds will be sought from federal funds.

It is believed that this project is unique in the history of education in several ways. There is no available information that a conference, of either educators or science supervisors, has ever been held which was organized with a statement of behavioral objectives, nor have attempts been made to determine the extent to which a conference has achieved its goals by a post-conference valuation. New software that will be produced will have implications far beyond their immediate usefulness because of

(1) plans for post-conference use with other supervisors, (2) setting a pattern for industry to follow in preparing software for other purposes, and (3) alerting educators to coming changes in curriculum organization and teaching techniques.

The project is being planned in three stages:

Stage I: The identification of the problems and needs of science supervisors, and the development of behavioral objectives for the working conference for science supervisors.

Stage II: The development of the software for use in the working conference, the formulation of detailed plans for the working conference, and organization of post-conference materials that may be used with supervisors and others who did not attend the conference.

Stage III: The supervisor's working conference and distribution of post-conference materials.

METHODS

An initial set of objectives was prepared by the project staff; however, no attempt was made to make these all inclusive. These objectives were used as a starting point for discussion during a two-day meeting of supervisors held on June 2 and 3, 1967. The supervisors were chosen from the membership of the National Science Teachers Association and represented as wide a cross section of the supervisory population as possible. The meeting produced a more refined set of objectives (appendix d) and outlined plans for the proposed institute (appendix c).

During the same period letters were sent to 41 firms seeking information concerning available software and possible interest in the production of future software. In general, the replies were favorable and indicated industry interest (appendix a,b). No attempt was made at this point to collect or evaluate possible software material.

From the above activities it was possible to prepare an initial work schedule for development materials and an approach to packaging the learning sequences (appendix e).

RESULTS

The basic results of the project are found in the appendices covering:

(1) Objectives (d)

(2) Work schedule for developing materials for science supervisor's institute (e)

(3) Package development for NSTA institute (f)

(4) Time table for work schedule (g)

The objectives have been refined as a result of meetings with supervisors held on June 27, 1967 and are the work of a representative group of science supervisors chosen from the membership of the National Science Teachers Association.

CONCLUSIONS

This report marks the completion of the second phase of preparation for a science supervisor's institute. The information obtained, which is shown in apendices c through g, provides a firm basis for the preparation of instructional material to be used in the institute. The approach taken has emphasized the need for objectives in order to prevent the usual blind groping toward an unspecified goal. Since the institute will also be designed to enable the supervisors to apply educational technology to the instructional process, the development plans seek to teach educational technology using educational technology.

With the basis of information provided in this report, definite plans for structuring the institute could begin. This resulted not only in a work schedule, but also in a package development concept. The schedule provides the functions necessary for software development. Considerable emphasis is placed on individualized instruction. The approach is based, as it should be on precise objectives. Much of the software will be packaged in learning modules, to enable the institute participants to teach themselves at their own speed whenever possible.

In order to begin preparation of learning material, its is now necessary to establish a hierarchy of objectives and begin a study of the proposed supervision population to be affected by the instructional program. This work will be the opening activity of Phase III which builds directly on the work carried out up to this point.

October 16, 1967

Letter Sent to Industries
Regarding Materials for N.S.T.A.
Science Supervisors Institute

Dear Mr. Baker:

The National Science Teachers Association, with the cooperation of the National Science Supervisors Association, is making plans for a ten-day Institute for Science Supervisors during the summer of 1968. The purpose of the Institute is to acquaint science supervisors and others in leadership positions throughout the nation with new developments in educational technology. As a part of the Institute, we wish to provide science supervisors first-hand experience in working with programed science materials that utilize a variety of technological devices.

We wish to learn about new instructional modules that have been developed or are in the process of development, so that we may consider them for use at the Institute. In order to identify such materials, we have developed the enclosed set of criteria to describe what we consider to be an ideal program. Not all of the criteria are pertinent to any one program, and the last two items in the list will apply only to the use of the materials in the local district.

We are aware that few, if any, of the present programs will meet all of the pertinent criteria. However, we are hoping that we can locate some materials presently available or in the process of development that will meet several of these criteria. Also, we are hoping that some industrial groups may become interested in developing an experimental module that would meet all of the criteria pertinent to the program.

Does your company have any science materials--designed for any grade level--that would meet several of the criteria? If so, would you please send us information about them, including (1) the subject content and grade level, (2) data concerning the development of the material, including the objectives of the program and the results of experimental use, (3) information about the type of hardware, (if any) needed to utilize the material, and (4) specifically, which of the included criteria are met by the materials?

If you do not have such material presently available or in the process of development, would you be interested in cooperating with us in developing a short demonstration module that would meet most, if not all, of the pertinent criteria in the list?

Sincerely yours,

/s/Albert F. Eiss
Associate Executive Secretary

SUGGESTED CRITERIA FOR SELECTING PROGRAMMED MATERIALS FOR SCIENCE INSTRUCTION

Designed for the use of local school district administrators and supervisors.

Materials for a desirable programmed course will have the following characteristics:

A. The Teacher's Manual

A teacher's manual is provided which contains

1. A complete list of objectives, stated in behavioral terms. The goals are compatible with an accepted philosophy of science education, such as "The NSTA Position on Curriculum Development in Science." The goals reflect:

   a. Emphasis on the student's ability to demonstrate an understanding of scientific principles and concepts

   b. Emphasis on the process of science as well as on content. This includes the student's ability to think and project ideas.

   c. Compatibility with a K-12 (or beyond) science sequence.

2. A subject content outline (Table of Contents)

3. Information about the resource persons who assisted in the development (authors, consultants, reviewers, etc.)

4. Suggestions on how to use the program as part of an instructional system, including

   a. A statement of how the program can be related to the rest of the curriculum.

   b. A statement of prerequisite knowledge, as measured by the threshold knowledge test mentioned in item B-2

   c. A statement of the type(s) and amount of hardware required.

5. Data on experimental use of the program, including

   a. Pre-test and final test scores, dispersion measures, probability status of differences (if appropriate) and approximate learning time

   b. Learner characteristics (attitudes, aptitudes, entry-level, achievement)

c. Composition of test population

d. Description of conditions of experimental use, including supervision, techniques of administration, method of use of materials and data collection

B. The Program

The program contains the following items:

1. An introduction for students which explains how to use the program and gives a list of general objectives

2. A threshold knowledge test, to determine whether the student possesses the minimum prerequisite knowledge and skills necessary to succeed in the program and to determine his placement in it.

3. A pre-test, interim tests, and a final test which contain criterion test items to insure effective progress in the program

4. Content divisions in the body of the program by chapter or unit headings

5. Alternative provisions for individual differences. Examples:

   a. Provisions for entering and exiting at various points

   b. Parallel programs for students with different abilities and backgrounds

   c. Branching programs

6. There are frequent checks on the student's progress, with provision for return to the proper place if learning is inadequate

7. The content is scientifically accurate

8. The program is compatible with available hardware

C. Local Field Testing

1. The results of field tests under local conditions with the assistance of technical specialists are satisfactory.

COMPANIES CONTACTED

Accelerated Instruction Methods Corp.
Executive Vice President

Addison-Wesley Publishing Co., Inc.
C. Stuart Brewster

Allyn & Bacon, Inc.
William B. Ansbro

American Book Company
Robert F. Baker

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Jack Barlass

Astra Corporation
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Behavioral Research Laboratories
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Peter Shreck

CBS Laboratories
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The Welch Scientific Company
R. T. O'Connor
Technical Department

John Wiley & Sons, Inc., Publishers
W. G. Sutler
Vice President

Appendix b

SUMMARY OF RESPONSES

"The only material that we publish that might qualify for your consideration is a programmed text entitled, "Understanding the Metric System." I am enclosing a copy and the accompanying Teachers' Manual for your examination."

"We have a provisional plan for a K to 6, or possibly K to 8, program that will match your criteria quite closely....still in the planning phase of this job....welcome a chance to develop a demonstration unit that would serve us and you as a model....look forward to meeting with you to learn what you intend by your suggestion that we cooperate in the development of such a unit."

"I have attached a brief description and picture of our new system which might be of interest to you. If you think it would be appropriate, we will be happy to arrange a demonstration of this (Audio/Visual) system at your institute next summer. We will also keep your requirements in mind and if any of the programs on which we will be working appear to meet the criteria you outline for programmed materials, I will make sure the programming source is informed of your requirements."

"...have published a number of programmed booklets in various fields, including six in science....We have tried to hold as closely as possible to the suggested criteria in developing these programs....We have published a full description of our procedure in validating each program before publication, and I am sending a copy under separate cover....Our programs are all linear in character, although we are currently planning new programs that will include branching techniques. Each program includes an introduction for the students and a final review and self-test...."

"The careful thinking which has been expended in drawing up the criteria for selecting programmed materials can only be of value to science instruction. While we do not presently have materials which fit into this framework, we subscribe to the spirit of the guidelines you have established....I hope that the project you describe will culminate in giving direction to those of us committed to the creation of outstanding science learning materials. If I can be of assistance in your future work, please let us know...."

"Your program strikes us as an interesting one, and you can be sure that we are eager to cooprate with you in any way that we can....At present we have two projects under way here which possibly would be of interest to your program planners...single-concept films correlated with elementary science series...set of models directly correlated with the science series...as teaching aids, both the films and the models represent a new approach to science instruction...."

Appendix b

"Although this is an area of considerable interest at the present time to educators, I believe that the amount of avilable tested and fully evaluated programmed materials that meet the criteria that you have established is quite limited....If, as the institute develops, it is determined that there are other ways in which we can be of assistance to you in the presentation of your program, I hope that you will keep us in mind."

"We are quite interested in cooperating with you in an effort to develop new modules that might meet present needs in education. After you have had an opportunity to review the type of materials we presently provide, perhaps you could get some suggestions relative to a joint program."

"...most interested in your designation of "Suggested Criteria for Selecting Programmed Materials for Science Instruction." Certainly the listing gives direction to those of us who are interested in the preparation and publication of such materials...."

"We are grateful that you contacted us as possible exhibitors at this meeting, and although we are developing materials for science teachers, we are not at the point yet where we have anything to display....regret we cannot participate...."

Appendix c

JOINT PLANNING CONFERENCE FOR NSSA REGIONAL WORKSHOPS

and the

NSTA TEN-DAY SCIENCE SUPERVISOR'S WORKSHOP ON
Behavioral Objectives and Educational Technology

AGENDA FOR FRIDAY, JUNE 2, 1967 SESSION

Morning Session: The Potential of Technology for Education

9:00-9:30 Registration and Coffee

9:30-10:00 "The Future of Education as Seen from the Point of View of Research"

R. Louis Bright, Associate Commissioner of Education for Research, USOE

10:00-10:30 "What's New About Educational Technology?"

Robert C. Snider, Assistant Director for the Division of Educational Technology, NEA

10:30-11:30 "The Importance of Behavioral Objectives" -- A Videotape

Gabriel D. Ofiesh, Director, Center for Educational Technology, Catholic University of America

11:45-1:30 Lunch

Afternoon Session: Plans for Action

1:30-2:15 NSTA-NSSA Projects now Under Way

Albert F. Eiss, Associate Executive Secretary, NSTA

2:15-3:15 USOE Plans for Action

Robert Morgan, Deputy Director, Division of Adult and Vocational Research, USOE

3:15-3:30 Coffee Break

3:30-5:00 Implications for Future Action

Reactions from Science Supervisors

A. Clair Brewer, President, NSSA

Reactions from Industry

Robert Nassau, Systems Editor
Industrial Systems Division, McGraw-Hill

Appendix c

PLANNING SESSION FOR SUPERVISOR'S CONFERENCE

on Educational Technology

AGENDA FOR SATURDAY, JUNE 3, 1967

9:00	Summary of Goals for the Group
	Outline Plans for a Ten-day Science Supervisor's Workshop
	1. Select content - state objectives
	2. Make tentative time allotments
	3. Revise objectives in behavioral terms
9:30 - 11:00	Define Goals and Suggest Timetable
11:00 - 1:00	Develop Criteria for Selection of Participants
	Suggest Types of Hardware That Might be Used
	Revise Objectives in Behavioral Terms if Possible
1:15 - 2:30	Lunch
2:30	Adjourn

Appendix c

RESULTS OF PLANNING SESSION FOR SUPERVISORS INSTITUTE

(June 3, 1967)

Participants in the planning session arrived at the following statement of tentative objectives for the institute:

Objectives of the 10-Day institute (things supervisors should do during the conference or afterward)

1. Identify behavioral objectives in science education
2. Write behavioral objectives in science education
3. Validate behavioral objectives in science education
4. Distinguish between criterion testing and normative testing
5. Write a criterion test for a set of behavioral objectives.

Distinguish between good and bad programs, machines, packages, etc., apply criteria

Distinguish between functions best served by human teachers and those served by technological devices in achieving representative objectives (cognitive, effective, psychomotor)

Operate hardware of present educational technology (list items)

Explain to other teachers/supervisors how to operate hardware (list items)

Develop and demonstrate illustrative materials

Identify and use sources of information on hardware, software, systems, etc.

Write a short program of specific objectives

Describe outcomes of recent significant research in use of educational technology (e.g. Briggs & Markle)

Explain the systems approach

The methods to be used should emphasize direct participation, include small group discussions, and arrange for the observation of children using innovative materials and media.

ROSTER OF PARTICIPANTS

for the

JOINT PLANNING CONFERENCE FOR NSSA REGIONAL WORKSHOPS

and the

NSTA TEN-DAY SCIENCE SUPERVISOR'S WORKSHOP ON Behavioral Objectives and Educational Technology

FRIDAY, JUNE 2, 1967

Martin Annis	American Science and Engineering, Inc. Cambridge, Massachusetts
David G. Barry	Commission on Undergraduate Education in the Biological Sciences, Washington, D. C.
Robert D. Binger	State Department of Education Tallahassee, Florida
A. Clair Brewer	Springfield (Missouri) Public Schools
R. Louis Bright	Associate Commissioner for Research U. S. Office of Education, Washington, D. C.
Annie Sue Brown	Atlanta (Georgia) Public Schools
John Butler	National Science Foundation, Washington, D. C.
David R. Colin	Olivetti Underwood, New York City
Gilbert Davidson	American Science and Engineering, Inc. Cambridge, Massachusetts
Albert F. Eiss	National Science Teachers Association Washington, D. C.
C. Joseph Frank	John Wiley & Sons, Inc., New York City
Marjorie H. Gardner	University of Maryland, College Park Earth Science Curriculum Project, Boulder, Colorado
Gary A. Griffin	Center for the Study of Instruction, N.E.A. Washington, D. C.
Helen E. Hale	Board of Education of Baltimore County Towson, Maryland
Raymond Hannibal	National Sciences Foundation, Washington, D. C.

Mary B. Harbeck	Philadelphia, Pennsylvania
Jesse Harris	Dallas (Texas) Independent School District
Mary E. Hawkins	National Science Teachers Association Washington, D. C.
Charles Koepke or Louise Cason	Xerox Corporation, New York City
Edwin B. Kurtz	American Association for the Advancement of Science Washington, D. C.
Morris R. Lerner	Barringer High School, Newark, New Jersey
J. David Lockard	American Institute of Biological Sciences Washington, D. C.
Richard J. Merrill	Unified School District, Concord, California
Richard F. Mohr	Laidlaw Brothers, River Forest, Illinois
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Morris H. Shamos	New York University, New York City President, National Science Teachers Association
Sr. M. Ambrosia, IHM	Archdiocese of Detroit, Michigan
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Appendix d

STATEMENT OF BEHAVIORAL OBJECTIVES FOR THE SCIENCE SUPERVISORS INSTITUTE

1.0 GENERAL STATEMENT

The primary function of the Institute will be to train the Institute participants in the management and decision-making process as it relates the application of Educational Technology to the Science Education Curriculum. Therefore, the statement of objectives focuses on the decision-making process in which science supervisors will be involved, as they attempt to apply the principles and procedures of Educational Technology in their own situations. This, of necessity, requires that participants concern themselves with general principles of Educational Technology and consider specific applications as being only illustrative of the general concepts. Because systems analysis is a technique of scientific problem-solving upon which to base curriculum decision-making, the Institute objectives will provide a structure which introduces and describes the basic concepts of the systems approach.

Within this framework, the Institute will deal with such topics as: the function of the teacher in the classroom; individualized instruction; affective goals of education; sources of information on educational technology; problems and methods of introducing and implementing change in a school system.

2.0 METHODOLOGY

The methodology used in the Institute will be based on Educational Technology. The design and development of the learning materials with correlated educational packages will be the primary focus of this project. In other words,

the proposal will seek the development of self-instructional educational packages to achieve the objectives of the Institute. In turn, the Institute content will focus on the development of efficient and validated educational packages for science education as illustrative vehicles.

A self-instructional educational package (Learning System) is a systematic arrangement of components of an educational experience in a manner that facilitates its transportation, assembly, and use by teacher and student. The package contains a prescription of the characteristics of the target population for which it was designed, pre/post tests, instructional units, and guidelines for administration, including specific instructions for the utilization of equipment and configuration of the environment. As a product of educational technology, the self-instructional package consists of empirically proved, validated learning experiences instrumented for replication. The process of packaging requires that considerable attention be devoted to conceptualization, design, production, its demonstration capabilities, dissemination potential, evaluation and validation procedures.

3.0 GENERAL OBJECTIVES

Supervisors will acquire the knowledge, understandings, and skills related to educational technology to the extent necessary to enable them to:

3.1 Explain to educational administrators (superintendents, principals, etc.) to science teachers at all levels of education, and to others the meaning and implications of educational technology in a way that will encourage its acceptance and successful application.

3.2 Describe the relationships between hardware and software aspects of educational technology and identify the kinds of hardware and software through which educational technology is applied.

3.3 Identify examples of media and materials for science instruction which meet minimum quality and performance standards in light of the same criteria proposed by N.S.T.A. for publishers of programmed materials.

3.4 Begin to utilize the principles of educational technology presented in the Institute for an evaluation of their own science curricula.

3.5 Develop a positive attitude toward educational technology. (It is hypothesized that this objective will be achieved partly by presenting programmed materials by means of a variety of new media.)

4.0 SPECIFIC OBJECTIVES

Such verbs as the following will be used to designate the category, KNOWLEDGE: identify; name; list; describe.

Such verbs as the following will be used to designate the category, SKILL: write; use; demonstrate.

Objectives in the UNDERSTANDING category will be designated by such verbs as: discriminate; explain; evaluate; develop; apply.

Conditions of performance, where not specified, will be included later. In general, a "90% correct" performance level will be required.

THE PARTICIPANT WILL BE ABLE TO:

4.1 Explain the four basic elements of educational technology and their relationship to science education.

4.1.1 Explain the necessity for the explicit description of the educational requirement (terminal behavior) in science education.

4.1.1.1 Explain the necessity for behaviorally defined and measurable objectives.

4.1.2 Explain the necessity for identifying and describing very explicitly the competencies possessed by the science education student at all levels of education.

4.1.2.1 This will necessitate a description of entry level characteristics both for:

4.1.2.1.1 Threshhold level knowledge, skills, and attitude (diagnostic or threshhold knowledge testing)

4.1.2.1.2 The degree to which the student has already acquired some level of mastery of terminal behavior.

4.1.3 Explain the necessity for determining the nature of the behavioral deficiency between entry level behavior and terminal level behavior.

4.1.4 Explain the requirement for determining the necessary software (message design) and hardware (media) strategies for producing the kind of learning necessary to appropriately modify the behavior of the student in predetermined directions.

4.2 Explain the function and properties of the systems approach.

4.2.1 Describe the procedure for systems design and development as presented in the Markle film, "Programing is a Process" or one similar to it.

4.2.2 Describe the common elements of the systems approach and their relationship to educational technology.

4.2.3 Describe the relationship of programming as a process both to the systems approach and to educational technology.

4.3 Discriminate between instructional objectives for science which meet criteria of the type recommended by Mager, Short, and others to be specified, and instructional objectives for science which do <u>not</u> meet those criteria.

4.3.1 Evaluate descriptions of observable behaviors for academically acceptable "Appreciate" and "Understand" objectives (discriminating acceptable objectives from unacceptable ones).

4.3.2 Identify behavioral objectives for science learning both in the cognitive and affective domains.

4.3.3 Explain how the attainment of science education objectives can assist the student to prepare for life work and growth.

4.4 Apply recommended guidelines in the selection of effective instructional media.

4.4.1 Name various kinds of electronic media, state appropriate uses of each, and name an example of an actual application of each.

4.4.2 Use evaluation checklists to identify examples of hardware media which meet minimum performance requirements established by the educational consumer.

4.5 Use and demonstrate to others the use of instructional equipment and media.

4.6 To identify programmed instructional materials (software) which meet criteria recommended by N.S.T.A. or similar criteria.

4.7 Describe the operation of an individualized instructional program and its application in three actual situations.

4.8 Describe the function of the teacher in a classroom using individualized instruction.

4.9 Describe at least six (6) problems likely to be encountered in the implementation of educational innovation.

4.9.1 To identify effective techniques of applying solutions of problems involved in the implementing of innovation.

4.9.2 Use information and materials acquired at the Institute to develop means of successfully implementing science education innovations in his local school system.

4.10 Given a list of 15 professional organizations in the field of education and approximately 20 titles of professional publications in education, psychology and electronics technology, the participant will identify at least 3 organizations and 6 publications which provide information about Educational Technology and make at least one statement with respect to each one of them which describes that organization or publication's purpose and mission.

Appendix e

WORK SCHEDULE FOR DESIGN AND DEVELOPMENT OF INSTRUCTION

(12 months project)

	Activity	Man-Days	Personnel
1.0	Organization of present objectives into modules Beginning Event: Start grouping of related objectives. Ending Event: Finish grouping objectives.	15 days	Science conultant, psychologist, programmer
2.0	Gather information on subject population Beginning Event: Specify characteristics for which information is needed. Ending Event: Complete description of target population.	10 days	Science conultant
3.0	Develop Assessment Instruments Beginning Event: Begin writing questionnaire, criterion test and threshold knowledge test. Ending Event: Analyse results of above and revise objectives where indicated.	50 days	Science consultant, psychologist, administrative assistant
3.1	Develop attitude questionnaire Beginning Event: Write and send out questionnaires to institute participants. Ending Event: Analyse and tabulate answers.		
3.2	Develop criterion test Beginning Event: Begin writing test items for each learning act. Ending Event: Complete test writing.		

4.0	Determine hierarchy of subordinate content principles and prerequisite capabilities (learning acts) for each objective. Beginning Event: Start developing hierarchy for each objective. Ending Event: Complete hierarchies.	40 days	Science consultant, psychologist programmer, media specialist.
4.1	Analyze each objective to determine hierarchies. Beginning Event: Perform required research necessary to analyse each objective. Ending Event: State subordinate content principles and prerequisite capabilities for each objective.		
5.0	Design instructional strategies for each specific objective (hierarchy of learning acts). Beginning Event: Specify type of learning represented in each learning act. Ending Event: Describe or designate media, methods and materials to be used.	30 days	Psychologist, programmers, media specialist
5.1	Determine type of learning reqpresented by each learning act (principle) Beginning Event: Examine each learning act. Ending Event: Label each learning act.		
5.2	Specify learning conditions necessary for the learning of each principle. Beginning Event: Note type of learning involved for each principle. Ending Event: State learning conditions for each principle.		

5.3	Describe instructional sequences, step by step, for each learning act. Beginning Event: Determine characteristics of required stimulus situations, necessary verbal directions, feedback, and means of motivating. Ending Event: State the steps of the instructional procedure.		
5.4	Select media and methods for each learning act. Beginning Event: State acceptable options for each learning act. Ending Event: Make final selection on basis of most frequently occurring options, cost factors and need for variety of hardware.		
5.5	Describe organization of media and materials into packages for each terminal objective.		
6.0	Develop or select materials and media for instruction . Beginning Event: Develop specifications for preparation or selection of media and materials. Ending Event: For materials developed in-house, make revisions based on small group trails. For other materials accept or reject on basis of trial results and other specs. Select media (hardware) on basis of specs.	100 days	Science consultant, programmers, trial subjects, media specialist, visual arts specialist, administration assistant.
6.1	Develop specification for preparation or selection of media and materials.		
6.2	Write necessary draft scripts, programs and instructions for audio, visual and printed materials of instruction (in-house) Beginning Event: Make writing assignments and begin writing. Ending Event: Revise materials based on small group trails and subject expert review.		
6.3	Coordinate preparation of materials by outside firms.		

	Beginning Event: Transmit specifications for development of materials. Ending Event: Accept or reject on basis of specifications and trial results.		
6.4	Coordinate production of instructional materials. Beginning Event: Write production specifications, slides, films tapes and other materials and distribute for production. Ending Event: Accept or reject on basis of production specification.		
6.5	Assemble hardware to be used to present materials or make arrangements for use of hardware, Beginning Event: Start contacting organizations for the use of hardware. Ending Event: Complete arrangements for necessary hardware.		
7.0	Validate instructional packages in large group trial. Beginning Event: Select test subjects. Ending Event: Revise materials on basis of analysis of results.	50 days	psychologist, media specialist, administrative assistant, programmers, test subjects.
8.0	Preparation of final report. Beginning Event: Gather all data and information. Ending Event: Deliver report to Office of Education.	30 days	Entire staff

PACKAGE DEVELOPMENT FOR NSTA INSTITUTE

GENERAL COMMENT

A learning systems package is a set of systematically organized units of learning materials. The packages will need to be developed for the following areas with each one being considered a separate and discreet unit:

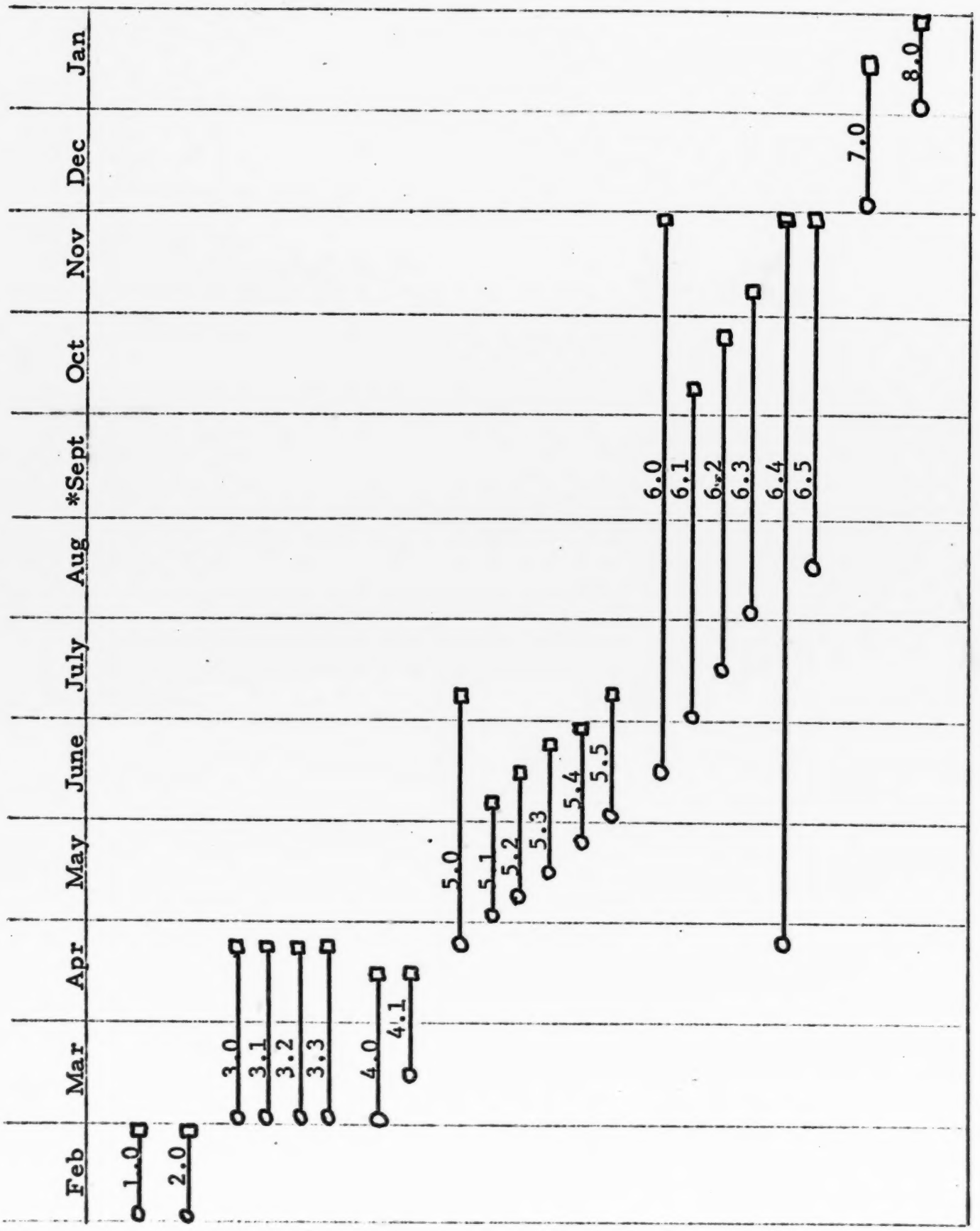
Content	Personnel (Developers)
I. Orientation: terminology, objectives, format of the Institute	NSTA staff and professional consultants
II. History, need for and description of educational technology	Professional consultants - for example - Dr. Deterline's materials, etc.
III. Description of learning systems	NSTA staff, professional consultants - for example - New York State biology program
IV. Design and development of learning systems	AAAS (Science as a Process)
A. Behavioral objectives and criterion testing	National Science Foundation, Xerox (also example of Xerox nucleonics program)
B. Analysis of target population	NSTA staff and professional consultants
C. Instructional strategy (this will include a variety of hardware presenting science materials in a variety of formats to be developed for illustrative Purposes. "How to Use" instructions are to be included in presentations.	Specifically to be worked out and established subsequent to the Proposal being granted.
1.0 Overhead transparencies 2.0 Educational radio 3.0 Tele-lecture 4.0 Tele-lecture and blackboard bu wire 5.0 Slide tape presentations (programmed) 6.0 Slide tape presentations (non-programmed) synchronized	Possible companies where media may be obtained (to be decided at a later date): Chester Electronics Corporation Systems Development Corporation

7.0	16 mm film presentation with group discussion and book (non-programmed)	Westinghouse Learning Corp.
8.0	16 mm film presentation (programmed)	Sylvania
9.0	8 mm filmclip cartridge (continuous loop) silent	Raytheon
10.0	8 mm filmclip cartridge (continuous loop) audio	General Learning Corporation
11.0	8 mm filmclip cartridge (programmed) silent	Local D.C. television
12.0	8 mm filmclip cartridge (programmed) audio	N.A.E.B.
13.0	Instructional television with multi-media presentation (non-programmed)	Local non-commercial television
14.0	Instructional television with multi-media presentation (programmed)	Philco-Ford
15.0	Videotape recording and playback	DAVI
16.0	Audio-visual tutorial presentation (direct and remote access) i.e., dial access	NSPI
		Ogden Technological Labs.
		Xerox Educational Division
		Quality Educational Dev. Corp.
		C.B.S. Labortories
		Graflex
17.0	Computer mediated instruction (type-writer keyboard and cathode ray tube)	McAllister
18.0	Electronic teaching systems or machines (student response systems both indi-vidual and group use)	Bell Telephone Company
		Borg Warner Corporation
19.0	Teaching machines	Responsive Environment Corp.
	19.1 C.B.S. A.V. machine	American Institutes for Research
	19.2 Borg Warner A.V. machine	
	19.3 ERA 501	Dage-Bell
	19.4 Autotutor	
V	School computer applications	Naval Academy (Physics course) N.Y. State Biology for teachers course Philadelphia Philco-Ford program
VI	Applications for instructional television	N.A.E.B.

VII	Load of teacher and individualized instruction	In-house, liason with Oakleaf school system, Duluth, Minn. school system, University of Pittsburgh Learning Resource Laboratory
VIII	Problems with implementation	To be determined
IX	Evaluation of educational technology (hardware and software)	In-house with DAVI and NSPI
X	Sources of information	In-house with DAVI, NEA and NSPI

TIME TABLE

(Based on Work Schedule - Appendix e)



* At this point the completed units will be validated by a small group of science supervisors.

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